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ABSTRACT

This paper evaluates the performance of engineering institutions in graduating minority freshmen. The four indices identified include: (1) the total number and proportion of minority graduates; (2) the proportion of full-time minority freshmen who earned a bachelor's degree in engineering; (3) the retention rate of minorities relative to the retention rate of nonminorities; and (4) the total number and proportion of entering full-time minority freshmen. Findings indicate that financial aid awards may be the key variables to consider at the policy level to improve the minority retention rate in engineering across all institutions. (CCM)

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Keeping What We've Got:
The Impact of Financial Aid on Minority Retention in Engineering

By Annie Georges

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Research Letter

Keeping What We've Got:

The Impact of Financial Aid on Minority Retention in Engineering

by Annie Georges, Ph.D.

Highlights

- Nationally, the retention rate of African Americans, Latinos, and American Indians in engineering is 36.5 percent based on an analysis of the entering freshman classes from 1991 to 1993 and graduating classes from 1996 to 1998. This is a slight improvement in the minority graduation rate from NACME's previous estimate of 35.0 percent in 1995. However, the gap between the rates at which minorities and nonminorities graduate has grown. The graduation rate of nonminority freshmen is 68.3 percent, up from 59.3 percent for a similar period ending in 1995.
- At current graduation rates, a minority student entering a college engineering program is only half as likely (53.4 percent) to obtain a bachelor of science degree in engineering as a nonminority student. This is a widening of the disparity in retention rates since 1995 when relative retention was 59.1 percent.
- The retention rate for African American freshmen is 32.3 percent; for American Indians 34.0 percent; and for Latinos 44.5 percent. African Americans and American Indians graduate at less than half the rate of nonminority freshmen, approximately 47.3 percent and 49.8 percent respectively. Latinos graduate at nearly two-thirds (65.0 percent) the rate of nonminorities.
- Of the eight Historically Black Colleges and Universities (HBCUs) that met the criteria for inclusion in the study, four have a minority retention rate that is higher than the national minority retention rate of 36.5 percent. The average retention rate for African Americans at the HBCUs is higher than the national African American retention rate: 36.1 percent compared to 32.3 percent.
- Of the five Hispanic Association of Colleges and Universities (HACUs) members that met the criteria for inclusion in the

Continued on page 2

Introduction

During the last 25 years, engineering institutions have made enormous progress in providing access to underrepresented minorities. In 1997-98, 6,374 African Americans, Latinos, and American Indians earned bachelor of science degrees in engineering.[1] Despite the overall progress, however, the number of African American and American Indian graduates actually declined for the first time in almost a decade; only Latinos made significant gains. Looking toward the future, an erosion in the overall number of minority engineering graduates is presaged by the fact that the enrollment of minority freshmen has declined eight percent since its peak in 1992-93; the enrollment of African Americans declined a devastating 17 percent during these six years.

The recent drops in the number of minority freshmen entering the nation's engineering schools raises the urgency of retaining minority students already enrolled. This study continues NACME's series on the performance of engineering institutions in retaining minority freshmen through graduation. As in our earlier studies, the objective is to develop a better understanding of the institutional factors that determine success in encouraging retention through the bachelor's degree. Our findings reveal that financial aid awards may be key variables that can be considered at the policy level to improve the minority retention rate in engineering across all institutions. Clearly, with declining minority enrollment, it is imperative that we do a better job of keeping what we've got.

Background

In this study we use four indices to evaluate the performance of engineering institutions in graduating minority freshmen: 1) the total number and proportion of minority graduates; 2) the proportion of full-time minority freshmen who earned a bachelor's degree in engineering, which we refer to interchangeably as the retention rate or the graduation rate; 3) the retention rate of minorities relative to the retention rate of nonminorities, which we term the relative retention index;[2] 4) and the total number and proportion of entering full-time minority freshmen. The inclusion of minority freshman enrollment data among our indices is important for two reasons: first because it allows us to assess the pool of available talent for future production of graduates and second, it gives us a window into institutional commitment in the face of a continuing decline in minority freshman enrollment in engineering programs across the nation, particularly among African Americans. Moreover, an analysis of entering freshman enrollment readily identifies institutions where greater effort is needed if the number of minority engineers is to increase over time.

Minority Enrollment and Graduation

This analysis is based on the entering freshman classes from 1991-92, 1992-93,

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and 1993-94, and the graduating classes of 1995-96, 1996-97, and 1997-98. During the years covered by the study the number of minority students enrolling in engineering programs increased slightly from 14,153 in 1991-92 to 14,384 in 1993-94, an overall percentage change of 1.6 percent. The number of minority graduates grew 1.0 percent from 6,331 in 1995-96 to 6,374 in 1997-98.[3]

Figure 1 shows that the distribution of minority graduates among engineering institutions remained much as it was during the 1980s and early 1990s, highly skewed with a small number of institutions producing the bulk of the minority graduates. Nationally, while the average minority graduating class was 18, we found that 35 institutions graduated an average of 50 or more minority engineers per year from 1996 to 1998. Among those 35 institutions, 10 graduated an average of 100 or more minority engineers per year. North Carolina A&T State University had the greatest number of minority graduates, an average of 244 engineers annually during the years included in the study. The small number of institutions with a high average number of minority graduates reflects a similar distribution in the number of institutions with a high average number of minority freshmen (Figure 2).

We also looked at the minority share of the graduating class in order to better quantify the achievement of smaller institutions. Overall, the average minority representation in the graduating class was ten percent. Twenty-five institutions had a minority representation significantly above the national average with graduating classes at least 30 percent minority or greater. Of these, 15 were HBCUs and seven were HACUs. An additional ten institutions had a minority representation of at least twice the national average.

National Retention Rates

In estimating a national retention rate, comparisons of aggregate enrollment with aggregate graduation data for a given cohort provide an incomplete picture of performance because of such institutional differences as the time it takes to complete a bachelor's degree, the point at which students can declare their major, and the possibility that students transfer to other institutions. In order to account for these confounding factors, NACME defined parameters for inclusion and used an averaging algorithm to estimate both national and institutional retention rates (see Computing the Retention Rate). Our final sample was comprised of 117 institutions for which we compared the entering freshman classes of 1991 to 1993 with the graduating classes of 1996 to 1998, and found that nationally, 36.5 percent of minority freshmen (African Americans, Latinos, and American Indians) are retained through graduation (see Tables 1 and 2). This is a slight improvement in the retention rate for minorities reported in our previous two studies.[4] In contrast, there has been a significant improvement in nonminority retention since 1995, from 59.3 percent to 68.3 percent (Table 3).

Although the retention of minority freshmen increased, the more substantial change in nonminority retention has resulted in a widening of the gap between the rates at which minorities graduate relative to nonminorities. The relative retention index of 53.4 percent shows that a minority student entering engineering is only half as likely to obtain a bachelor's degree as a nonminority student. This is an increase in the disparity since 1995 when the estimated relative retention index was 59.1 percent for a similar sample of institutions.

Disaggregating the data, we also examined graduation rates for African Americans, Latinos, and American Indians separately. We found the retention of African Americans and American Indians to be below the national average for all minority students; 32.3 percent of African Americans and 34.0 percent of American Indians who enrolled, graduated during the period covered by the study. In contrast, the retention rate for Latinos was 44.5 percent. In terms of the relative retention index, this means that African Americans graduate at less than half (47.3 percent) the rate of nonminority freshmen; American Indians graduate at nearly half (49.8 percent) the rate of nonminorities; and Latinos graduate at almost two-thirds (65.0 percent) the rate of nonminorities.

Retention Rates at HBCUs and HACUs

A large proportion of African Americans and Latinos earn their bachelor's degrees in engineering from Historically Black Colleges and Universities (HBCUs) and

Highlights (continued)

study, two have a minority retention rate that is higher than the national average. The University of Texas-San Antonio achieved a minority retention rate of 75.0 percent, surpassing even the national nonminority retention rate of 68.3 percent. The average retention rate for Latinos at the HACUs, however, is lower than the national Latino retention rate, 36.0 percent compared to 44.5 percent.

- The average number of minority graduates for all 348 engineering institutions was 18 during the period covered by this study. Only 35 institutions graduated an average of 50 or more minority engineers per year during that time. Ten of these institutions graduated an average of 100 or more minority engineers per year. North Carolina A&T State University graduated the greatest number of minority engineers — an average of 244 per year during the study period.
- The minority retention rate at highly selective institutions is well above the national average; 49.5 percent of enrolling minority freshmen graduate. At non-selective institutions the minority retention rate is only 17.6 percent. Although, in general, the retention rate of minorities and nonminorities is correlated with selectivity, the performance of individual institutions within each level of selectivity varies widely.
- The availability of financial aid is an important factor in accounting for the differences in the performance of individual institutions. The retention of minorities in engineering seems to be more responsive to changes in financial aid awards than to any other factor we considered in this analysis. Hence, financial aid may be a key policy variable for improving minority retention.

Figure 1
Distribution of Minority Graduates
1996-98

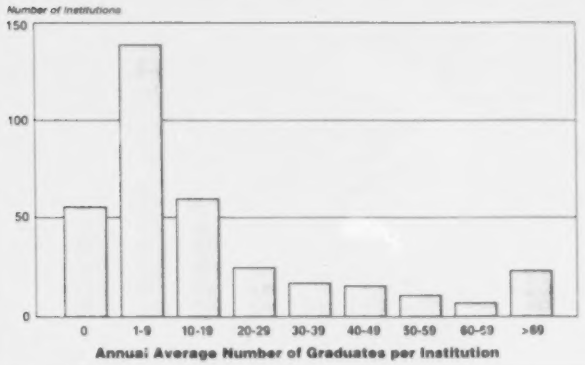
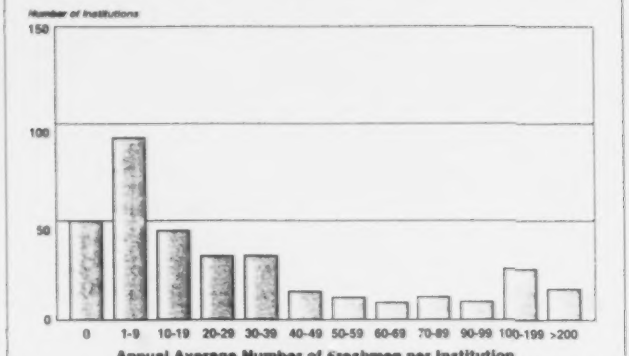


Figure 2
Distribution of Minority Freshmen
1991-93



member institutions of the Hispanic Association of Colleges and Universities (HACUs), respectively. The HBCUs and HACUs represent 11.1 percent of the sample of institutions that met the criteria for inclusion, and they accounted for 32.4 percent of the minority graduating class. The average minority retention rate at HBCUs is 36.3 percent; and the retention rate for African Americans at those institutions is 36.1 percent. Though the overall minority retention rate at HBCUs is lower than the national minority retention rate of 36.5 percent, note that the retention rate for African Americans is higher than the national average for African Americans overall (32.2 percent). Among HACUs the average minority retention rate is 35.0 percent, which is lower than the national average for all institutions. Moreover, the Latino retention rate at the HACUs is only 36.0 percent compared to a 44.5 percent retention rate for Latinos overall (Table 4).

Freshman Enrollment: Precursor to Minority Graduations

Recall that Table 1 shows the retention rates for each of the institutions included in the study, listed alphabetically, and Table 2 shows the same institutions ranked by minority retention rate and relative retention index. In examining these tables we found a number of institutions that performed better than the national average in both minority retention rates and relative retention indices. However, their success was mitigated by the fact that the minority share of the freshman class and the graduating class was very small. The institutions with the best retention rates (60 percent or better) enroll, on average, fewer than 42 minority students annually, which was the national average minority freshman class during the period covered by the study. Moreover, minorities constituted less than 16 percent of the freshman class at all of the institutions with the best retention rates, which was the average share of the freshman class nationally. Table 5 lists all engineering institutions ranked by the number of minority graduates and minority freshmen.

Regrettably, institutions that perform poorly in retaining minority students tend to enroll a higher percentage of minority freshmen. Minorities constituted more than 25 percent of the freshman class at those institutions with below average minority retention rates (see Table 5). A low yield from these institutions is a lost opportunity for increasing the number of minority engineers, where incremental improvements

Computing the Retention Rate

To compute a national retention rate we compared the average entering freshman cohorts from 1991-92, 1992-93, and 1993-94 to the graduating cohorts from 1995-96, 1996-97, and 1997-98. This averaging smooths variations in the amount of time students take to graduate. We also minimized other distortions in the data by accounting for institutional differences in the time at which students can declare a major and the possibility that students transfer to other institutions before graduating.

Institutions that acquire engineering majors after a first cohort may have an overstated freshman graduation rate. We, therefore, filtered out institutions with potentially skewed graduation rates by examining changes in enrollment between the freshman-to-sophomore and sophomore-to-junior classes. A 15 percent increase in the total number of students (minority or nonminority) was the point at which we excluded institutions.

In order to assure that the institutions had a sufficient minority population to allow an assessment of relative performance, we eliminated all institutions with fewer than 10 minority freshmen for the years 1991 to 1993. Moreover, only institutions with complete enrollment and graduation data for all the years covered by the study were included. The appendix lists all institutions that were not included in the final sample, and the reason for their exclusion.

For the resulting sample of 117 institutions we compared freshman cohorts to the graduating cohorts. This comparison yielded a minority graduation rate of 36.5 percent, and a 68.3 percent nonminority graduation rate.

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Table 1

Freshman Retention Rate and Relative Retention Index for Engineering Institutions, Listed Alphabetically

Institution	Minority Freshman Retention Rate (%)	Nonminority Freshman Retention Rate (%)	Relative Retention Index (%)	Average Minority Freshman Class 1991-94	Average Minority Graduating Class 1995-98	Average Nonminority Freshman Class 1991-94	Average Nonminority Graduating Class 1995-98
Auburn University	31.6	56.7	55.7	120	38	934	529
Brown University	19.4	53.8	36.2	24	5	119	64
Cal Poly-Pomona	54.3	74.8	72.6	125	68	530	396
Cal Poly-San Luis Obispo	44.1	94.2	46.8	166	73	645	607
Cal State U-Fullerton	25.2	76.3	33.0	44	11	96	73
Cal State U-Los Angeles**	34.2	96.1	35.6	99	34	60	58
Clarkson University	61.1	82.1	74.4	18	11	363	298
Clemson University	35.1	59.1	59.3	123	43	752	445
Colorado School of Mines	41.9	62.6	66.9	64	27	634	397
Colorado State University	39.0	74.1	52.6	33	13	295	219
Duke University	52.1	87.7	59.4	32	17	219	192
Embry Riddle Aeronaut U	33.3	41.7	79.9	24	8	242	101
Florida Institute of Tech	41.3	57.7	71.7	25	10	222	128
George Mason University	52.9	103.6	51.0	29	15	176	182
George Washington Univ	37.2	46.4	80.2	26	10	142	66
Howard University*	45.6	33.8	134.8	188	86	24	8
Illinois Inst of Tech	38.4	71.6	53.7	81	31	230	164
Iowa State University	17.2	53.7	32.0	78	13	1246	669
Kansas State University	26.9	53.4	50.3	36	10	615	328
Kettering University	57.6	80.5	71.6	39	23	434	349
Lamar University	24.4	51.6	47.3	53	13	160	82
Lawrence Technological U	34.9	77.7	44.9	43	15	305	237
Lehigh University	68.6	84.3	81.5	17	12	381	321
Louisiana State Univ	22.2	40.3	55.0	129	29	805	325
Louisiana Tech University	29.0	43.4	66.8	52	15	361	157
Loyola Marymount Univ	37.7	57.2	65.8	23	9	58	33
Manhattan College	57.6	72.5	79.5	28	16	149	108
Marquette University	40.6	62.7	64.7	23	9	385	242
Michigan State University	16.8	60.3	27.9	232	39	880	530
Michigan Tech University	42.1	75.8	55.5	36	15	1004	762
Milwaukee School of Engrg	26.2	49.5	52.9	28	7	441	219
Mississippi State Univ	30.5	88.5	34.5	119	36	353	312
Morgan State University*	30.4	87.5	34.7	251	76	11	9
NC A&T State University*	58.9	127.3	46.3	415	244	33	42
NC State Univ-Raleigh	43.8	77.3	56.6	172	75	1146	886
NM State University**	31.2	57.7	54.1	240	75	280	161
Northern Arizona Univ	17.3	57.2	30.3	94	16	181	103
Northern Illinois Univ	6.3	39.2	15.9	43	3	184	72
Northwestern University	78.9	91.7	86.1	32	25	312	286
Oakland University	15.2	78.3	19.3	33	5	165	129
Ohio State University	20.8	53.1	39.2	150	31	1201	638
Ohio University	23.3	54.5	42.8	30	7	345	188
Oklahoma State Univ	32.9	69.7	47.2	54	18	385	268
Old Dominion University	43.8	105.2	41.6	35	15	148	155
Penn State University	49.1	55.5	88.5	76	37	2057	1141
Polytechnic University	48.2	57.3	84.1	91	44	389	223
Prairie View A&M Univ*	43.3	52.9	81.8	326	141	28	15
Princeton University	65.2	83.8	77.7	30	19	186	156
Purdue University	61.0	74.4	82.0	130	79	1543	1148
Rensselaer Polytechnic	55.6	76.7	72.5	98	55	704	540
Rice University	30.2	83.1	36.4	54	16	178	148
Rutgers University	38.3	70.5	54.3	105	40	535	377
Santa Clara University	46.1	48.7	94.6	34	16	155	75
So Illinois-Carbondale	24.4	95.0	25.7	44	11	166	158
Southern University*	16.7	33.3	50.0	490	82	13	4
Stanford University	64.6	124.2	52.0	79	51	216	269
SUNY-Buffalo Campus	24.4	55.4	44.0	82	20	649	360
Syracuse University	33.8	72.6	46.6	44	15	213	155
Tennessee State Univ*	15.2	45.4	33.6	227	35	32	15
Tennessee Tech Univ	39.4	57.5	68.6	24	9	475	273
Texas A&M Univ-Kingsville**	44.8	67.2	66.7	181	81	86	58
Tulane University	57.9	65.5	88.3	32	18	218	143
Tuskegee University*	49.7	23.1	215.2	247	123	9	2
U Akron	14.4	35.3	40.8	58	8	625	220
U Alabama	21.7	46.0	47.2	129	28	437	201
U Alabama-Birmingham	31.7	89.6	35.4	35	11	89	80
U Alaska-Fairbanks	48.5	83.8	57.9	11	5	78	65
U Arizona	43.1	79.7	54.1	138	59	474	378
U Arkansas	20.6	63.3	32.5	60	12	383	242
U Cal-Davis	48.5	93.1	52.1	80	39	393	366
U Cal-San Diego	43.7	70.0	62.4	95	41	548	384
U Cal-Santa Cruz	42.9	89.4	48.0	16	7	53	48
U Central Florida	69.4	116.3	59.7	81	56	239	278
U Cincinnati	24.7	64.2	38.5	28	7	473	304
U Colorado-Boulder	66.9	75.3	88.8	54	36	540	406
U Delaware	31.8	57.3	55.5	36	11	235	135
U District of Columbia*	25.7	44.0	58.3	86	22	73	32
U Houston	37.4	78.3	47.7	118	44	252	198
U Idaho	73.0	61.2	119.1	12	9	310	190
U Illinois-Champaign	38.2	93.5	40.9	170	65	1152	1078
U Illinois-Chicago	48.0	101.4	47.3	98	47	301	305
U Kentucky	32.0	88.3	36.2	25	8	440	389
U Louisville	36.8	62.4	59.0	38	14	296	185
U Lowell	23.3	43.8	53.1	14	3	385	168
U Massachusetts-Amherst	58.0	61.5	94.3	27	16	327	201
U Michigan-Ann Arbor	45.3	92.7	48.9	188	85	969	898
U Michigan-Dearborn	55.8	88.7	62.9	14	8	195	173
U Mississippi	42.9	53.1	80.7	21	9	113	60
U NC-Charlotte	55.8	78.6	71.0	14	8	190	149
U Nevada-Las Vegas	30.2	42.7	70.6	35	11	200	85
U New Haven	27.8	74.8	37.1	12	3	85	63
U New Orleans	16.2	46.9	34.6	78	13	217	102
U Notre Dame	35.4	64.6	54.8	49	17	340	220
U Oklahoma	21.2	81.0	26.1	195	41	387	313
U Pennsylvania	51.5	76.5	67.3	32	17	378	289
U Pittsburgh	46.1	99.2	46.5	34	16	278	275
U Rhode Island	28.6	63.3	45.1	14	4	198	125
U Rochester	26.2	51.6	50.7	22	6	200	103
U South Alabama	22.6	51.3	44.0	31	7	223	115
U South Carolina	20.7	56.1	36.9	114	24	278	156
U Southern California	55.2	69.8	79.1	92	51	377	263
U Southern Colorado	15.9	12.0	133.1	15	2	31	4
U Southwestern Louisiana	10.3	36.0	28.6	58	6	248	89
U Tennessee-Knoxville	31.4	54.4	57.7	86	27	586	319
U Texas-Austin	36.0	71.7	50.2	335	121	949	681
U Texas-El Paso**	26.2	55.3	47.4	396	104	124	68
U Texas-San Antonio**	75.4	57.0	132.2	68	51	143	81
U Utah	38.0	86.4	44.0	17	5	325	281
U Virginia	62.8	79.2	79.4	49	31	386	306
U Wisconsin-Madison	31.4	73.8	42.6	35	11	810	598
U Wyoming	58.3	64.2	90.8	12	7	239	153
US Coast Guard Academy	34.3	55.9	61.3	12	4	99	55
Vanderbilt University	67.3	78.6	85.7	34	23	311	245
Virginia Poly Institute	41.7	75.0	55.6	82	34	1074	805
Western Michigan Univ	20.0	95.7	20.9	33	7	209	200
Wichita State University	21.2	73.6	28.7	17	4	217	160
Wright State University	16.9	55.1	30.7	43	7	295	162
All Institutions	36.5	68.3	53.4				
Total Minority Freshman Class	9746						
Total Minority Graduating Class	3557						
Total Nonminority Freshman Class	44275						
Total Nonminority Graduating Class	30248						

Note: Sample selection criteria: 1) Engineering institutions included in the Engineering Workforce Commission (EWC) database; 2) Institutions with complete enrollment and graduation data; 3) A yearly average minority freshman class of at least 10; 4) Institutions with increases in minority or nonminority freshman-to-sophomore and sophomore-to-junior enrollments that do not exceed 15 percent.

* HBCU
** HACU

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Table 2

Engineering Institutions Ranked by Minority Retention Rates and Relative Retention Index

Institution	Minority Freshman Retention Rate (%)	Nonminority Freshman Retention Rate (%)	Relative Retention Index (%)	Rank by Minority Retention Rate	Rank by Relative Retention Index
Northwestern University	78.9	91.7	86.1	1	12
U Texas-San Antonio**	75.4	57.0	132.2	2	4
U Idaho	73.0	61.2	119.1	3	5
U Central Florida	69.4	116.3	59.7	4	42
Lehigh University	68.6	84.3	81.5	5	17
Vanderbilt University	67.3	78.6	85.7	6	13
U Colorado-Boulder	66.9	75.3	88.8	7	9
Princeton University	65.2	83.8	77.7	8	24
Stanford University	64.6	124.2	52.0	9	64
U Virginia	62.8	79.2	79.4	10	22
Clarkson University	61.1	82.1	74.4	11	25
Purdue University	61.0	74.4	82.0	12	15
NC A&T State University*	58.9	127.3	46.3	13	81
U Wyoming	58.3	64.2	90.8	14	8
U Massachusetts-Amherst	58.0	61.5	94.3	15	7
Tulane University	57.9	65.5	88.3	16	11
Kettering University	57.6	80.5	71.6	17	29
Manhattan College	57.6	72.5	79.5	17	21
U Michigan-Dearborn	55.8	88.7	62.9	19	39
U NC-Charlotte	55.8	78.6	71.0	19	30
Rensselaer Polytechnic	55.6	76.7	72.5	21	27
U Southern California	55.2	69.8	79.1	22	23
Cal Poly-Pomona	54.3	74.8	72.6	23	26
George Mason University	52.9	103.6	51.0	24	65
Duke University	52.1	87.7	59.4	25	43
U Pennsylvania	51.5	76.5	67.3	26	33
Tuskegee University*	49.7	23.1	215.2	27	1
Penn State University	49.1	55.5	88.5	28	10
U Alaska-Fairbanks	48.5	83.8	57.9	29	47
U Cal-Davis	48.5	93.1	52.1	29	63
Polytechnic University	48.2	57.3	84.1	31	14
U Illinois-Chicago	48.0	101.4	47.3	32	74
Santa Clara University	46.1	48.7	94.6	33	6
U Pittsburgh	46.1	99.2	46.5	33	80
Howard University*	45.6	33.8	134.8	35	2
U Michigan-Ann Arbor	45.3	92.7	48.9	36	70
Texas A&M Univ-Kingsville**	44.8	67.2	66.7	37	36
Cal Poly-San Luis Obispo	44.1	94.2	46.8	38	78
NC State Univ-Raleigh	43.8	77.3	56.6	39	49
Old Dominion University	43.8	105.2	41.6	39	89
U Cal-San Diego	43.7	70.0	62.4	41	40
Prairie View A&M Univ*	43.3	52.9	81.8	42	16
U Arizona	43.1	79.7	54.1	43	57
U Cal-Santa Cruz	42.9	89.4	48.0	44	71
U Mississippi	42.9	53.1	80.7	44	18
Michigan Tech University	42.1	75.8	55.5	46	52
Colorado School of Mines	41.9	62.6	66.9	47	34
Virginia Poly Institute	41.7	75.0	55.6	48	51
Florida Institute of Tech	41.3	57.7	71.7	49	28
Marquette University	40.6	62.7	64.7	50	38
Tennessee Tech Univ	39.4	57.5	68.6	51	32
Colorado State University	39.0	74.1	52.6	52	62
Illinois Institute of Tech	38.4	71.6	53.7	53	59
Rutgers University	38.3	70.5	54.3	54	56
U Illinois-Champaign	38.2	93.5	40.9	55	90
U Utah	38.0	86.4	44.0	56	84
Loyola Marymount Univ	37.7	57.2	65.8	57	37
U Houston	37.4	78.3	47.7	58	72
George Washington Univ	37.2	46.4	80.2	59	19
U Louisville	36.8	62.4	59.0	60	45
U Texas-Austin	36.0	71.7	50.2	61	68
U Notre Dame	35.4	64.6	54.8	62	55
Clemson University	35.1	59.1	59.3	63	44
Lawrence Technological U	34.9	77.7	44.9	64	83
US Coast Guard Academy	34.3	55.9	61.3	65	41
Cal State U-Los Angeles	34.2	96.1	35.6	66	99
Syracuse University	33.8	72.6	46.6	67	79
Embry Riddle Aeronaut U	33.3	41.7	79.9	68	20
Oklahoma State Univ	32.9	69.7	47.2	69	76
U Kentucky	32.0	88.3	36.2	70	97
U Delaware	31.8	57.3	55.5	71	52
U Alabama-Birmingham	31.7	89.6	35.4	72	100
Auburn University	31.6	56.7	55.7	73	50
U Tennessee-Knoxville	31.4	54.4	57.7	74	48
U Wisconsin-Madison	31.4	73.8	42.6	74	88
NM State University**	31.2	57.7	54.1	76	57
Mississippi State Univ	30.5	88.5	34.5	77	103
Morgan State University*	30.4	87.5	34.7	78	101
U Nevada-Las Vegas	30.2	42.7	70.6	79	31
Rice University	30.2	83.1	36.4	79	96
Louisiana Tech University	29.0	43.4	66.8	81	35
U Rhode Island	28.6	63.3	45.1	82	82
U New Haven	27.8	74.8	37.1	83	94
Kansas State University	26.9	53.4	50.3	84	67
U Texas-El Paso**	26.2	55.3	47.4	85	73
U Rochester	26.2	51.6	50.7	85	66
Milwaukee School of Engrg	26.2	49.5	52.9	85	61
U District of Columbia*	25.7	44.0	58.3	88	46
Cal State U-Fullerton	25.2	76.3	33.0	89	105
U Cincinnati	24.7	64.2	38.5	90	93
Lamar University	24.4	51.6	47.3	91	74
So Illinois-Carbondale	24.4	95.0	25.7	91	114
SUNY-Buffalo Campus	24.4	55.4	44.0	91	84
U Lowell	23.3	43.8	53.1	94	60
Ohio University	23.3	54.5	42.8	94	87
U South Alabama	22.6	51.3	44.0	96	84
Louisiana State Univ	22.2	40.3	55.0	97	54
U Alabama	21.7	46.0	47.2	98	76
U Oklahoma	21.2	81.0	26.1	99	113
Wichita State University	21.2	73.6	28.7	99	110
Ohio State University	20.8	53.1	39.2	101	92
U South Carolina	20.7	56.1	36.9	102	95
U Arkansas	20.6	63.3	32.5	103	106
Western Michigan Univ	20.0	95.7	20.9	104	115
Brown University	19.4	53.8	36.2	105	97
Northern Arizona Univ	17.3	57.2	30.3	106	109
Iowa State University	17.2	53.7	32.0	107	107
Wright State University	16.9	55.1	30.7	108	108
Michigan State University	16.8	60.3	27.9	109	112
Southern University*	16.7	33.3	50.0	110	69
U New Orleans	16.2	46.9	34.6	111	102
U Southern Colorado	15.9	12.0	133.1	112	3
Tennessee State Univ*	15.2	45.4	33.6	113	104
Oakland University	15.2	78.3	19.3	113	116
U Akron	14.4	35.3	40.8	115	91
U Southwestern Louisiana	10.3	36.0	28.6	116	111
Northern Illinois Univ	6.3	39.2	15.9	117	117

Note: Sample selection criteria: 1) Engineering institutions included in the Engineering Workforce Commission (EWC) database. 2) Institutions with complete enrollment and graduation data. 3) A yearly average minority freshman class of at least 10. 4) Institutions with increases in minority or nonminority freshman-to-sophomore and sophomore-to-junior enrollments that do not exceed 15 percent.

* HBCU

** HACU

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Figure 3

1998 Retention Rates by Academic Selectivity

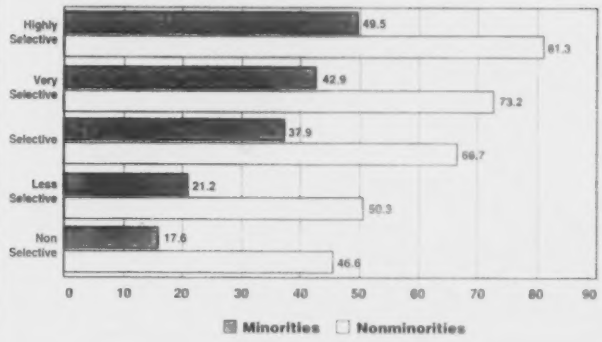
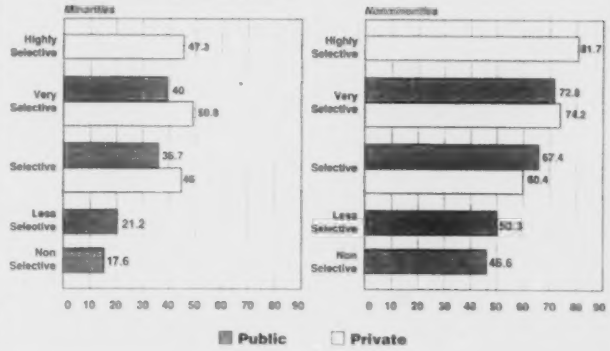


Figure 4

1998 Retention Rates by Academic Selectivity and Institutional Control



would create measurable growth in production.

Retention Rates and Selectivity

Selectivity is an index[5] that denotes the rigor of the academic standards used as admission criteria by institutions. Institutions are grouped among five selectivity levels based on three parameters: the percentage of applicants who are accepted for admission, the high school class rank and the standardized test scores of the students who enroll at the institution.

Previous NACME research as well as the current study confirm that minority students perform extremely well at top engineering institutions. For both minority and nonminority freshmen, retention is positively associated with academic selectivity. Figure 3 shows that the retention rate of minorities at highly selective and very selective institutions is well above the national average (36.5 percent). Specifically, at highly selective institutions 49.5 percent of the minority freshmen from the 1991 to 1993 classes graduated between 1996 and 1998, compared to 81.3 percent of nonminority freshmen. Although the gap in graduation rates between minorities and nonminorities remains substantial, the highly selective institutions are demonstrating much greater productivity than the non-selective institutions. At these schools — those that accept all freshman applicants — the minority freshman retention rate is 17.6 percent compared to 46.6 percent for nonminority freshmen.

The positive association between retention rates and academic selectivity applies to private and public institutions. Figure 4 shows the retention rates for minority and nonminority freshmen at public and private institutions after controlling for academic selectivity. In general, minority students are retained at considerably higher rates at private than at public institutions, by about ten percentage points at very selective and selective institutions.[6] In contrast, there exists little difference in the nonminority retention rates at private and public institutions, after controlling for academic selectivity. Although minority and nonminority freshman retention rates increase as the institution's academic selectivity increases, it is also important to note that the performance of individual institutions differs greatly within each academic selectivity group.

Table 3

National Engineering Retention Rates and Relative Retention Index

Study Period	Retention Rate Minorities (%)	Retention Rate Nonminorities (%)	Relative Retention Index (%)
1980-81 - 1989-90	35.6	68.4	52.0
1986-87 - 1992-93	35.0	59.3	59.0
1991-92 - 1997-98	36.5	68.3	53.4

Source: NACME Research Letter, Vol. 7, No. 2, 1997, and NACME Research Letter, Vol. 8, No. 2, 1998.

Impact of Financial Aid

The variation in retention rates across institutions has been attributed to individual student factors such as precollege academic preparation and the level of commitment to completing a degree in engineering, and to institutional factors such as the level of commitment to assuring that students complete their degree, as reflected in the allocation of financial aid and grants to students.

We examined the impact of financial aid resources to explain the observed variability in minority retention rates across institutions. The results presented in Table 6 indicate that meeting the financial need of minority students may be a key factor in addressing the problem of attrition observed in these communities.[7] The correlation coefficients in the table indicate whether a statistically significant linear relationship exists between any two pairs of variables. The correlation between minority retention rate and the average scholarship and fellowship is positive and statistically significant. That is, the minority retention rate tends to be higher at those institutions with high average financial aid awards.

A study by the U.S. General Accounting Office indicates that, for students from low-income families, a shift of $1000 from loans to grants increases the probability of graduation by 17 percent.[8] However, our analysis

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shows that all financial aid sources do not have similar impact on retention. The four main sources are federal grants, state grants, privately funded financial aid from foundations, individuals and corporations, and institutionally funded financial aid awards. The results in Table 6 show that minority retention rates tend to be lower at institutions with high average federal Pell grant awards.

Over the last 20 years, the purchasing power of the federal Pell grant has declined from about 75 percent to about 33 percent of total college costs at public four-year institutions. At private four-year institutions the purchasing power of the maximum federal Pell grant award has declined from 35 percent to 13 percent during the same period.[9] Since the federal Pell grant is available primarily to low-income students, qualified students who receive it may have greater difficulty financing the costs of higher education at both public and private institutions.

Indeed, a recent study by The Education Resources Institute, Inc. (TERI) shows a wide disparity in net college costs by family income.[10] The study estimated that family resources for students in the lowest income quartile (below $40,000) could only cover 32 percent of net college expenses (after accounting for all grants) at a four-year public institution. On the other hand, for students in the highest income quartile attending college is very affordable. For these students, family resources can cover more than 70 percent of the net college costs at a four-year public institution. Hence, there exists enormous unmet need — at least 68 percent of net college costs — for students from low income families.[11]

The declining purchasing power of the federal Pell grant may be one of several factors driving up the net costs of a college education for the poorest segment of the population. Minority students, who are disproportionately from families with income below the poverty line, may be particularly affected by declines in grants at a time of rising college costs.

In addition, our results indicate that the decline in the purchasing power of Pell grants may be particularly consequential for students at public and selective institutions (which select students at the 50th percentile and higher of their high school graduating class), who are more likely to qualify for and be awarded these types of grants. The correlation coefficients also reveal a positive and significant linear correlation between Pell grant awards and public institutions, and between selective institutions and Pell grant awards. These positive correlations indicate that there are more qualified students receiving Pell grant awards at public and selective institutions, which have far fewer resources for financial aid to make up for the shortfall after federal grants are disbursed.

The correlation between public institutions and average financial aid from all sources is negative and significant. There is also a negative and significant correlation between selective institutions and average financial aid awards from all sources. These negative correlations indicate that public and selective institutions provide smaller financial aid awards. As a result, qualified students at those institutions who receive federal Pell grant awards may be less likely to find the additional financial resources needed to cover their college costs through graduation.

On the other hand, the correlation between minority retention rate and privately and institutionally funded financial aid is positive and statistically significant. This finding indicates that the retention of

Table 4
Freshman Retention Rate and Relative Retention Index, HBCUs and HACUs

Institution	Minority Freshman Retention Rate (%)	Nonminority Freshman Retention Rate (%)	Relative Retention Index (%)	Average Minority Freshman Class 1991-94	Average Minority Graduating Class 1995-98	Average Nonminority Freshman Class 1991-94	Average Nonminority Graduating Class 1995-98
HBCU							
Howard University	45.6	33.8	134.8	188	86	24	8
Morgan State University	30.4	87.5	34.7	251	76	11	9
NC A&T State University	58.9	127.3	46.3	415	244	33	42
Prairie View A&M Univ	43.3	52.9	81.8	326	141	28	15
Southern University	16.7	33.3	50.0	490	82	13	4
Tennessee State Univ	15.2	45.4	33.6	227	35	32	15
Tuskegee University	49.7	23.1	215.2	247	123	9	2
U District of Columbia	25.7	44.0	58.3	86	22	73	32
All HBCUs	36.3	57.3	63.3				
Total Minority Freshman Class	2230						
Total Minority Graduating Class	808						
Total African American Freshman Class	2216						
Total African American Graduating Class	799						
Total Nonminority Freshman Class	222						
Total Nonminority Graduating Class	127						
HACU							
Cal State U-Los Angeles	34.2	96.1	35.6	99	34	60	58
NM State University	31.2	57.7	54.1	240	75	280	161
Texas A&M Univ-Kingsville	44.8	67.2	66.7	181	81	86	58
U Texas-El Paso	26.2	55.3	47.4	396	104	124	68
U Texas-San Antonio	75.4	57.0	132.2	68	51	143	81
All HACUs	35.0	61.6	56.8				
Total Minority Freshman Class	984						
Total Minority Graduating Class	345						
Total Latino Freshman Class	905						
Total Latino Graduating Class	326						
Total Nonminority Freshman Class	693						
Total Nonminority Graduating Class	427						

Note: Sample selection criteria: 1) HACU and HBCU Engineering institutions included in the Engineering Workforce Commission (EWC) database. 2) Institutions with complete enrollment and graduation data. 3) A yearly average minority freshman class of at least 10. 4) Institutions with increases in minority or nonminority freshman-to-sophomore and sophomore-to-junior enrollments that do not exceed 15 percent.

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Table 5

Engineering Institutions Ranked by Number of Minority Graduates and Minority Freshmen

Institution	Average Minority Graduating Class (1996-98)	Rank Minority Graduates	Average Nonminority Graduating Class (1996-98)	Average Minority Freshman Class (1981-83)	Rank Minority Freshmen	Average Nonminority Freshman Class (1981-83)	Average Number Graduates	Percent Minority Graduates (%)	Average Number Freshmen	Percent Minority Freshmen (%)
NC A&T State University*	244	1	42	415	2	33	286	85.3	448	92.6
Georgia Inst of Tech	189	2	1111	205	14	1419	1301	14.6	1624	12.6
Florida Intl University**	171	3	114	47	82	23	285	60.1	70	67.1
Prairie View A&M Univ*	141	4	15	326	7	28	156	90.4	354	92.0
Texas A&M University	127	5	1021	352	5	1544	1148	11.1	1895	18.6
FAMU/FSU College of Engrg*	126	6	146	309	8	177	272	46.3	485	63.6
Tuskegee University*	123	7	2	247	10	9	125	98.4	256	96.6
U Texas-Austin	121	8	681	335	6	949	801	15.1	1284	26.1
CCNY (City College, CUNY)	104	9	155	409	3	294	259	40.3	703	58.2
U Texas-El Paso**	104	9	68	396	4	124	172	60.3	519	76.2
Mass Inst of Technology+	99	11	571	0	296	0	670	14.8	0	0.0
U Florida	88	12	607	0	296	1	695	12.7	1	0.0
Howard University*	86	13	8	188	18	24	94	91.5	212	88.8
U Michigan-Ann Arbor	85	14	898	188	18	969	983	8.6	1157	16.2
Southern University*	82	15	4	490	1	13	86	95.0	503	97.4
Texas A&M Univ-Kingsville**	81	16	58	181	20	86	139	58.3	267	67.7
New Jersey Inst Tech	81	16	291	194	17	420	372	21.8	614	31.5
Purdue University	79	18	1148	130	28	1543	1227	6.5	1673	7.8
Morgan State University*	76	19	9	251	9	11	86	89.1	262	95.9
NC State Univ-Raleigh	75	20	886	172	21	1146	962	7.8	1318	13.0
NM State University**	75	20	161	240	11	280	236	31.7	520	46.2
Cal Poly-San Luis Obispo	73	22	607	166	23	645	680	10.7	810	20.4
Cal State U-Long Beach	69	23	325	140	25	203	394	17.5	343	40.7
Cal Poly-Pomona	68	24	396	125	31	530	464	14.6	655	19.0
U Illinois-Champaign	65	25	1078	170	22	1152	1143	5.7	1322	12.9
U South Florida	61	26	294	30	123	115	355	17.2	145	20.6
U Arizona	59	27	378	138	27	474	437	13.6	612	22.5
U Maryland-College Park	59	27	423	61	67	511	482	12.2	572	10.7
U Central Florida	56	29	278	81	53	239	334	16.8	319	25.3
U Miami	55	30	76	67	62	133	131	41.8	200	33.3
Rensselaer Polytechnic	55	30	540	98	42	704	595	9.2	803	12.3
Stanford University	51	32	269	79	56	216	320	16.0	295	26.7
U Texas-San Antonio**	51	32	81	68	61	143	132	38.5	210	32.2
U Southern California	51	32	263	92	46	377	314	16.2	470	19.7
U New Mexico**	50	35	124	123	32	138	174	28.6	261	47.0
U Illinois-Chicago	47	36	305	98	42	301	352	13.3	399	24.6
Polytechnic University	44	37	223	91	48	389	267	16.4	480	18.9
U Cal-Berkeley	44	37	737	58	69	547	781	5.6	606	9.6
Florida Atlantic Univ	44	37	143	33	111	95	187	23.7	128	25.8
U Houston	44	37	198	118	36	252	242	18.2	370	31.8
Clemson University	43	41	445	123	32	752	488	8.8	875	14.0
San Diego State Univ	43	41	182	69	60	205	225	19.0	275	25.2
San Jose State University	41	43	370	46	83	413	411	9.9	459	10.0
U Cal-Los Angeles	41	43	398	64	65	415	439	9.3	480	13.4
U Cal-San Diego	41	43	384	95	44	548	425	9.7	643	14.7
Cornell University	41	43	667	65	63	725	707	5.7	789	8.2
U Oklahoma	41	43	313	195	15	387	355	11.7	582	33.6
Arizona State University	40	48	367	53	76	381	407	9.7	434	12.2
Rutgers University	40	48	377	105	40	535	418	9.7	641	16.4
Michigan State University	39	50	530	232	12	880	569	6.9	1112	20.9
U Cal-Davis	39	50	366	80	55	393	405	9.6	473	17.0
Auburn University	38	52	529	120	34	934	567	6.7	1054	11.4
Penn State University	37	53	1141	76	59	2057	1179	3.2	2133	3.6
U Washington	37	53	622	21	151	34	659	5.7	54	38.0
U Colorado-Boulder	36	55	406	54	73	540	443	8.2	594	9.1
Cal State U-Sacramento	36	55	209	92	46	180	245	14.8	272	33.8
Mississippi State Univ	36	55	312	119	35	353	348	10.4	472	25.2
US Naval Academy	35	58	347	116	37	654	382	9.2	771	15.1
Tennessee State Univ*	35	58	15	227	13	32	49	70.3	260	87.5
U Texas-Pan American**	34	60	6	0	296	0	40	85.8	0	0.0
Virginia Poly Institute	34	60	805	82	51	1074	840	4.1	1157	7.1
Cal State U-Los Angeles**	34	60	58	99	41	60	92	37.0	160	62.2
Texas Tech University	33	63	251	111	39	504	284	11.6	615	18.1

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Institution	Average Minority Graduating Class (1996-98)	Rank Minority Graduates	Average Nonminority Graduating Class (1996-98)	Average Minority Freshman Class (1991-93)	Rank Minority Freshmen	Average Nonminority Freshman Class (1991-93)	Average Number Graduates	Percent Minority Graduates (%)	Average Number Freshmen	Percent Minority Freshmen (%)
Ohio State University	31	64	638	150	24	1201	669	4.7	1351	11.1
Cal State U-Northridge	31	64	146	140	25	179	177	17.5	319	43.9
Illinois Inst of Tech	31	64	164	81	53	230	195	15.9	310	26.0
U Virginia	31	64	306	49	80	386	337	9.2	435	11.3
Drexel University	29	68	372	65	63	466	401	7.2	531	12.3
Louisiana State Univ	29	68	325	129	29	805	353	8.1	934	13.8
US Military Academy	28	70	275	0	296	0	304	9.3	0	0.0
U Alabama	28	70	201	129	29	437	229	12.2	566	22.8
U Tennessee-Knoxville	27	72	319	86	49	586	346	7.8	672	12.8
Colorado School of Mines	27	72	397	64	65	634	423	6.3	697	9.1
U Missouri-Rolla	26	74	578	46	83	737	604	4.4	783	5.9
Northwestern University	25	75	286	32	116	312	311	8.0	343	9.2
U South Carolina	24	76	156	114	38	278	179	13.2	392	29.2
Stevens Inst of Tech	24	76	151	39	94	206	175	13.9	245	16.1
NY Institute of Tech	24	76	76	27	133	61	100	24.1	88	31.1
Kettering University	23	79	349	39	94	434	372	6.1	473	8.3
US Air Force Academy	23	79	226	9	203	44	250	9.3	52	16.6
Vanderbilt University	23	79	245	34	106	311	267	8.5	345	9.8
Boston University	22	82	266	37	97	387	288	7.8	424	8.7
U District of Columbia*	22	82	32	86	49	73	54	40.7	158	54.1
Columbia University	21	84	230	18	159	228	252	8.5	245	7.2
Mercer University	21	84	156	23	146	116	176	11.7	139	16.3
U Cal-Santa Barbara	21	84	153	29	126	252	174	12.2	261	10.3
Cal State U-Fresno	21	84	99	51	79	177	120	17.2	227	22.3
U Cal-Irvine	20	88	166	33	111	222	165	10.6	255	12.9
U Texas-Arlington	20	88	225	23	146	205	245	8.0	228	9.9
Carnegie Mellon Univ	20	88	264	35	101	350	284	7.2	385	9.0
SUNY-Buffalo Campus	20	88	360	82	51	649	380	5.3	731	11.2
U Maryland-Baltimore	20	88	119	41	91	126	139	14.4	166	24.4
Princeton University	19	93	156	30	123	186	175	11.0	215	13.8
Tulane University	18	94	143	32	116	218	161	11.4	249	12.7
Oklahoma State Univ	18	94	268	54	73	385	286	6.2	439	12.2
Duke University	17	96	192	32	116	219	209	8.0	251	12.7
Wayne State University	17	96	141	55	72	214	158	10.8	269	20.3
U Pennsylvania	17	96	289	32	116	378	306	5.4	410	7.9
U Notre Dame	17	96	220	49	80	340	237	7.3	369	12.6
Hampton University*	17	96	1	195	15	0	18	92.7	195	100.0
Santa Clara University	16	101	75	34	106	155	91	17.2	189	18.0
Manhattan College	16	101	108	28	130	149	124	13.1	177	16.0
U Alabama-Huntsville	16	101	158	34	106	235	174	9.2	269	12.5
Washington State Univ	16	101	404	27	133	406	420	3.9	433	6.3
NM Inst of Mining & Tech	16	101	53	31	121	86	69	23.7	117	26.5
U Massachusetts-Amherst	16	101	201	27	133	327	217	7.2	354	7.6
U Pittsburgh	16	101	275	34	106	278	291	5.4	312	10.9
Rice University	16	101	148	54	73	178	164	10.0	232	23.3
Northern Arizona Univ	16	101	103	94	45	181	120	13.6	275	34.3
Case Western Reserve U	15	110	250	2	270	16	265	5.5	18	13.0
SUNY-Stony Brook Campus	15	110	90	17	163	122	106	14.5	139	12.0
George Mason University	15	110	182	29	126	176	197	7.8	205	14.2
Lawrence Technological U	15	110	237	43	88	305	252	5.9	348	12.3
Syracuse University	15	110	155	44	85	213	170	8.8	257	17.2
Louisiana Tech University	15	110	157	52	78	361	172	8.7	412	12.5
Michigan Tech University	15	110	762	36	98	1004	777	1.9	1040	3.4
Old Dominion University	15	110	155	35	101	148	171	9.0	183	19.2
Southern Methodist Univ	14	118	75	29	126	114	89	15.4	143	20.0
U Minnesota	14	118	603	25	139	574	617	2.3	599	4.1
U Louisville	14	118	185	38	96	296	199	7.0	334	11.4
Iowa State University	13	121	669	78	57	1246	682	2.0	1323	5.9
U New Orleans	13	121	102	78	57	217	114	11.1	295	26.5
Lamar University	13	121	82	53	76	160	95	13.6	213	25.0
U Texas-Dallas	13	121	153	8	207	33	166	7.8	41	19.4
Cooper Union	13	121	107	14	178	120	120	10.9	135	10.6
Northeastern University	13	121	233	18	159	307	246	5.3	325	5.5

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Table 5

Engineering Institutions Ranked by Number of Minority Graduates and Minority Freshmen

Institution	Average Minority Graduating Class (1996-98)	Rank Minority Graduates	Average Nonminority Graduating Class (1996-98)	Average Minority Freshman Class (1991-93)	Rank Minority Freshmen	Average Nonminority Freshman Class (1991-93)	Average Number Graduates	Percent Minority Graduates (%)	Average Number Freshmen	Percent Minority Freshmen (%)
U Detroit	13	121	48	20	155	66	61	21.7	86	23.3
Colorado State University	13	121	219	33	111	295	232	5.6	328	10.2
U Missouri-Columbia & KC	12	129	355	24	142	366	366	3.2	390	6.1
U Connecticut	12	129	158	27	133	229	170	7.3	256	10.4
Lehigh University	12	129	321	17	163	381	333	3.5	398	4.3
So Illinois-Edwardsville	12	129	130	4	246	12	142	8.4	16	23.4
U Arkansas	12	129	242	60	68	383	255	4.8	443	13.6
U Memphis	11	134	67	20	155	112	78	14.1	133	15.3
Clarkson University	11	134	298	18	159	363	309	3.6	381	4.7
Worcester Poly Institute	11	134	409	14	178	458	420	2.7	472	3.0
Cal State U-Fullerton	11	134	73	44	85	96	84	13.1	139	31.3
U Wisconsin-Madison	11	134	598	35	101	810	609	1.8	845	4.1
U Delaware	11	134	135	36	98	235	146	7.8	271	13.2
U Nevada-Las Vegas	11	134	85	35	101	200	96	11.1	235	15.0
So Illinois-Carbondale	11	134	158	44	85	166	168	6.3	210	20.8
U Alabama-Birmingham	11	134	80	35	101	89	91	12.1	124	28.0
U Colorado-Denver	11	134	108	4	246	33	119	9.5	37	10.7
Harvard University *	10	144	111	0	296	0	121	8.5	0	0.0
Kansas State University	10	144	328	36	98	615	338	2.9	651	5.5
Cleveland State Univ	10	144	126	16	168	164	135	7.1	180	8.7
Florida Institute of Tech	10	144	128	25	139	222	138	7.5	247	10.1
George Washington Univ	10	144	66	26	138	142	76	12.8	168	15.4
St Marys University**	10	144	6	15	173	22	16	60.4	37	39.6
Rochester Inst of Tech	10	144	226	29	126	329	236	4.1	358	8.2
Tennessee Tech Univ	9	151	273	24	142	475	282	3.3	499	4.7
San Francisco State University	9	151	71	16	168	72	80	11.2	89	18.4
Johns Hopkins University	9	151	207	17	163	232	216	4.2	249	6.7
Yale University	9	151	49	2	270	17	58	16.0	20	11.9
U Idaho	9	151	190	12	187	310	199	4.5	322	3.8
U Toledo	9	151	219	40	93	684	228	3.8	724	5.5
Marquette University	9	151	242	23	146	385	251	3.7	408	5.6
U Mississippi	9	151	60	21	151	113	69	13.0	134	15.7
U Tulsa	9	151	101	11	195	142	110	8.5	153	7.4
Loyola Marymount University	9	151	33	23	146	58	42	20.8	81	28.5
U Dayton	8	161	141	13	184	299	149	5.4	312	4.3
U Hartford	8	161	60	11	195	80	68	11.6	91	11.7
Brigham Young University	8	161	353	15	173	500	361	2.2	515	2.8
Washington University	8	161	198	12	187	200	207	4.0	212	5.5
U Michigan-Dearborn	8	161	173	14	178	195	181	4.4	210	6.8
U Wisconsin-Milwaukee	8	161	161	20	155	179	169	4.7	199	10.2
U Akron	8	161	220	58	69	625	229	3.6	683	8.5
Embry Riddle Aeronaut U	8	161	101	24	142	242	109	7.3	266	9.0
U Kentucky	8	161	389	25	139	440	397	2.0	465	5.4
U NC-Charlotte	8	161	149	14	178	190	157	5.1	204	7.0
U Wyoming	7	171	153	12	187	239	160	4.4	251	4.8
U Nevada-Reno	7	171	107	10	202	156	114	6.1	166	5.8
Cal Inst of Technology *	7	171	117	0	296	0	124	5.4	0	0.0
Hofstra University	7	171	29	9	203	55	36	18.5	64	14.6
Citadel	7	171	61	8	207	112	68	10.3	120	6.4
Ohio University	7	171	188	30	123	345	195	3.6	375	8.0
Norfolk State University*	7	171	0	41	91	1	7	95.2	42	98.4
Wright State University	7	171	162	43	88	295	170	4.3	338	12.8
West Virginia University	7	171	256	18	159	349	265	2.6	367	4.9
Milwaukee School of Engrg	7	171	219	28	130	441	226	3.2	469	6.0
U Cincinnati	7	171	304	28	130	473	311	2.3	502	5.6
U Kansas	7	171	232	21	151	324	240	3.1	345	6.0
U South Alabama	7	171	115	31	121	223	122	5.8	254	12.2
Western Michigan Univ	7	171	200	33	111	209	207	3.2	242	13.8
U Cal Santa Cruz	7	171	48	16	168	53	55	12.8	70	23.4
Cal State U-Chico	7	171	87	34	106	119	94	7.5	153	22.3
U Iowa	7	171	208	16	168	391	214	3.1	407	4.0
Temple University	6	188	43	6	220	26	49	12.8	33	19.4
U Southwestern Louisiana	6	188	89	58	69	248	95	6.3	307	19.0

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Institution	Average Minority Graduating Class (1996-98)	Rank Minority Graduates	Average Nonminority Graduating Class (1996-98)	Average Minority Freshman Class (1991-93)	Rank Minority Freshman	Average Nonminority Freshman Class (1991-93)	Average Number Graduates	Percent Minority Graduates (%)	Average Number Freshman	Percent Minority Freshmen (%)
Dartmouth College	6	188	113	11	195	74	120	5.3	85	12.6
U Pacific	6	188	51	11	195	62	57	10.5	73	15.1
SD School of Mines & Tech	6	188	187	11	195	340	193	3.1	351	3.1
U Rochester	6	188	103	22	150	200	109	5.2	222	9.8
U Cal-Riverside	6	188	37	9	203	50	43	13.3	59	15.3
Virginia Military Inst	6	188	73	12	187	119	79	7.2	131	9.1
Seattle University	6	188	74	5	228	64	80	7.9	69	6.6
U Utah	6	188	281	17	163	325	287	2.2	341	4.9
Purdue Univ-Calumet	5	198	38	16	168	57	42	11.0	73	21.9
Rose-Hulman Inst of Tech	5	198	216	8	207	300	222	2.4	308	2.6
U Hawaii	5	198	132	0	296	169	137	3.7	170	0.2
Portland State Univ	5	198	163	7	215	95	168	2.8	102	6.9
Oakland University	5	198	129	33	111	165	134	3.7	198	16.7
U Alaska-Fairbanks	5	198	65	11	195	78	71	7.5	89	12.4
Christian Brothers Univ	5	198	35	8	207	70	40	11.8	78	9.9
Harvey Mudd College	5	198	57	8	207	88	62	8.6	96	8.0
Brown University	5	198	64	24	142	119	69	6.8	143	16.8
Trenton State College	5	198	24	4	246	16	29	17.4	20	20.0
U Massachusetts-Dartmouth	4	208	44	4	246	150	47	7.7	154	2.8
U Rhode Island	4	208	125	14	178	198	129	3.1	212	6.6
Youngstown State Univ	4	208	90	5	228	248	94	4.2	252	1.8
Alfred U/SUNY Ceramics	4	208	73	6	220	121	77	5.2	127	4.7
Catholic Univ of America	4	208	49	6	220	53	53	7.6	59	10.2
U Colorado-Colorado Spgs	4	208	40	6	220	53	44	9.2	59	10.2
US Coast Guard Academy	4	208	55	12	187	99	59	6.7	111	10.5
Fairfield University	4	208	24	1	282	0	28	14.3	1	66.7
U Nebraska-Lincoln	4	208	279	7	215	382	283	1.5	389	1.8
West Coast University	4	208	12	0	296	0	16	25.0	0	0.0
Embry Riddle U-Prescott	4	208	62	8	207	161	66	6.1	169	4.7
Parks College-St Louis	4	208	54	7	215	60	58	7.4	67	10.9
Capitol College	4	208	15	5	228	3	16	20.0	8	64.0
Montana State University	4	208	200	13	184	459	204	2.0	472	2.8
Villanova University	4	208	152	13	184	261	156	2.4	274	4.6
Central State University*	4	208	4	32	116	7	8	47.8	39	82.2
Wichita State University	4	208	160	17	163	217	164	2.2	235	7.4
U Alaska-Anchorage	3	225	28	4	246	42	31	8.7	46	8.7
Humboldt State University	3	225	50	5	228	30	52	5.1	35	14.4
Tufts University	3	225	153	3	263	179	156	1.9	182	1.8
Purdue Univ-Indianapolis	3	225	65	3	263	37	68	3.9	40	6.7
Northern Illinois Univ	3	225	72	43	88	184	75	3.6	226	18.9
Union College	3	225	58	5	228	79	61	5.5	84	6.0
Bradley University	3	225	123	5	228	80	125	2.1	84	5.5
Walla Walla College	3	225	46	4	246	51	48	5.5	55	7.8
U Portland	3	225	56	2	270	65	59	4.5	67	3.5
Widener University	3	225	60	0	296	104	63	5.3	104	0.0
U Lowell	3	225	168	14	178	385	172	1.9	399	3.6
U New Haven	3	225	63	12	187	85	67	5.0	97	12.4
St Martins College	3	225	22	0	296	10	25	10.8	10	0.0
U Wisconsin-Platteville	3	225	196	12	187	536	198	1.5	548	2.2
Bucknell University	3	225	128	8	207	162	131	2.5	170	4.7
Alabama A&M University*	3	225	2	27	133	2	5	62.5	30	92.1
ND State University	3	225	280	5	228	305	283	1.2	310	1.7
Univ of North Florida	3	225	12	0	296	0	15	19.6	0	0.0
Miami University	3	225	84	7	215	127	86	3.1	135	5.4
SUNY Binghamton Campus	3	225	64	0	296	2	67	4.5	3	12.5
US Merchant Marine Academy	3	225	103	6	220	146	107	3.1	152	3.7
U New Hampshire	2	246	136	0	296	196	137	1.2	196	0.0
SUNY Maritime College	2	246	52	15	173	89	54	4.3	104	14.5
West Virginia Inst Technology	2	246	97	4	246	219	99	2.0	223	1.9
U Southern Colorado	2	246	4	15	173	31	6	38.9	45	32.4
Gonzaga University	2	246	54	6	220	86	56	3.0	92	6.9
SUNY College at New Paltz	2	246	20	5	228	15	22	9.2	20	25.4
McNeese State University	2	246	33	15	173	121	35	6.7	137	11.2

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Table 5

Engineering Institutions Ranked by Number of Minority Graduates and Minority Freshmen

Institution	Average Minority Graduating Class (1996-98)	Rank Minority Graduates	Average Nonminority Graduating Class (1996-98)	Average Minority Freshman Class (1991-93)	Rank Minority Freshmen	Average Nonminority Freshman Class (1991-93)	Average Number Graduates	Percent Minority Graduates (%)	Average Number Freshmen	Percent Minority Freshmen (%)
Montana Tech of U Montana	2	246	138	6	220	272	140	1.2	278	2.2
New Mexico Highlands U**	2	246	0	21	151	5	2	100.0	26	82.1
U Vermont	2	246	91	5	228	203	93	2.2	208	2.2
Saginaw Valley State U	2	246	41	7	215	55	43	4.6	62	11.2
Baylor University	2	246	22	9	203	71	24	8.2	80	10.9
Mass Maritime Academy	2	246	79	4	246	66	81	2.5	70	6.2
Lafayette College	2	246	99	8	207	120	101	1.7	128	6.0
Merrimack College	1	260	26	1	282	35	27	4.9	36	3.7
Colorado Technical University	1	260	29	0	296	0	30	3.3	0	0.0
Mankato State University	1	260	36	1	282	146	37	2.7	147	0.9
Northeastern State University	1	260	3	1	282	4	4	18.2	5	25.0
Trinity College	1	260	11	1	282	7	13	10.5	8	16.0
U Nevada-School of Mines	1	260	20	1	282	33	21	3.2	34	3.9
Cogswell College	1	260	12	0	296	0	13	7.7	0	0.0
Idaho State University	1	260	25	4	246	98	26	3.8	103	4.2
U San Diego	1	260	5	0	296	0	6	21.1	0	0.0
Oral Roberts University	1	260	11	0	296	14	12	8.6	14	0.0
Roger Williams University	1	260	19	0	296	0	19	3.4	0	0.0
Loyola College	1	260	9	2	270	16	10	10.3	18	11.1
Valparaiso University	1	260	57	4	246	86	58	1.7	91	4.8
Utah State University	1	260	183	6	220	237	184	0.5	243	2.3
Geneva College	1	260	19	0	296	23	20	3.3	24	1.4
Grand Valley State University	1	260	29	11	195	63	30	4.4	74	14.9
College of Staten Island	1	260	12	12	187	54	13	10.0	66	18.3
U Evansville	1	260	66	2	270	77	67	2.0	79	2.1
Indiana Inst of Tech	1	260	10	19	158	74	11	8.8	93	20.5
Cal Maritime Academy	1	260	12	5	228	33	12	5.4	38	13.0
Tri-State University	1	260	109	4	246	135	109	0.6	139	2.6
Purdue University-Ft Wayne	1	260	29	3	263	94	30	2.2	97	3.4
U Denver	1	260	11	4	246	40	12	5.6	44	9.2
SUNY College of Env Science	1	260	54	5	228	30	56	2.4	35	14.3
SD State University	1	260	148	3	263	358	148	0.4	361	0.7
U Georgia	1	260	23	4	246	22	24	4.2	26	15.4
Fairleigh Dickinson University	1	260	8	5	228	13	9	14.8	18	27.8
Wilkes University	1	260	47	2	270	58	47	1.4	60	3.4
Ohio Northern University	1	260	78	5	228	169	78	0.9	174	3.1
Texas A&M U-Galveston	1	260	23	4	246	37	24	5.6	41	10.5
Arkansas State University	1	260	33	5	228	122	34	2.9	127	4.2
U of Southern Maine	1	260	9	0	296	9	10	9.7	9	0.0
Swarthmore College	1	260	24	4	246	46	25	4.1	51	8.6
U Akron-Polymer Science	0	293	0	0	296	0	0	0.0	0	0.0
Marietta College	0	293	11	0	296	19	11	0.0	19	0.0
Oregon Grad Inst Sci/Tech	0	293	0	0	296	0	0	0.0	0	0.0
Cedarville College	0	293	29	0	296	0	29	0.0	0	0.0
U West Va-Grad Studies	0	293	0	0	296	0	0	0.0	0	0.0
Ferris State University	0	293	23	0	296	7	23	0.0	7	0.0
Wentworth Inst of Tech	0	293	9	0	296	0	9	0.0	0	0.0
Grove City College	0	293	55	0	296	138	55	0.0	138	0.0
Loras College	0	293	1	0	296	24	1	0.0	24	0.0
College of St Thomas	0	293	0	0	296	0	0	0.0	0	0.0
U Wisconsin-Parkside	0	293	0	0	296	4	0	0.0	4	0.0
Oregon State University	0	293	386	0	296	535	386	0.0	535	0.0
US Naval Postgraduate School	0	293	0	0	296	0	0	0.0	0	0.0
U NC-Chapel Hill	0	293	0	0	296	0	0	0.0	0	0.0
Cogswell College North	0	293	8	0	296	0	8	0.0	0	0.0
Pacific Lutheran University	0	293	7	0	296	0	7	0.0	0	0.0
U Texas-Permian Basin	0	293	0	0	296	0	0	0.0	0	0.0
Air Force Inst of Technology	0	293	0	0	296	0	0	0.0	0	0.0
U West Florida	0	293	5	0	296	0	5	0.0	0	0.0
Seattle Pacific University	0	293	19	0	296	28	19	1.8	28	0.0
Northrop University	0	293	0	0	296	0	0	0.0	0	0.0
Hartford Graduate Center	0	293	0	0	296	0	0	0.0	0	0.0
Dordt College	0	293	15	0	296	21	15	0.0	21	1.6

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Institution	Average Minority Graduating Class (1996-98)	Rank Minority Graduates	Average Nonminority Graduating Class (1996-98)	Average Minority Freshman Class (1991-93)	Rank Minority Freshmen	Average Nonminority Freshman Class (1991-93)	Average Number Graduates	Percent Minority Graduates (%)	Average Number Freshmen	Percent Minority Freshmen (%)
Inst of Paper Sci & Technology	0	293	0	0	296	0	0	0.0	0	0.0
U Maine-Orono	0	293	143	2	270	279	143	0.2	281	0.8
Messiah College	0	293	20	2	270	37	21	1.6	39	4.3
U Redlands	0	293	0	2	270	9	0	0.0	11	15.2
Monmouth College	0	293	3	2	270	11	3	0.0	13	15.4
Oklahoma Christian University	0	293	19	2	270	50	19	1.7	52	3.9
Pratt Institute	0	293	0	2	270	5	0	0.0	7	33.3
St Cloud State University	0	293	43	3	263	69	43	0.8	72	3.7
Phila Coll of Textiles	0	293	8	3	263	9	8	0.0	12	22.9
Gannon University	0	293	35	1	282	40	35	1.0	41	2.4
Le Tourneau University	0	293	36	3	263	79	36	0.9	82	3.6
Trinity University	0	293	7	4	246	53	7	0.0	57	6.4
Arkansas Tech University	0	293	22	4	246	78	22	1.5	81	4.5
Western New England College	0	293	55	5	228	84	56	0.6	89	5.3
U Bridgeport	0	293	9	5	228	36	9	0.0	40	11.6
St Ambrose University	0	293	4	1	282	3	4	0.0	5	28.6
Webb Inst of Naval Architecture	0	293	17	1	282	23	17	0.0	24	4.2
John Brown University	0	293	14	0	296	36	14	0.0	36	0.0
New England College	0	293	2	0	296	9	2	0.0	9	3.7
Marshall Univ Grad College	0	293	0	0	296	0	0	0.0	0	0.0
Winona State University	0	293	22	0	296	0	22	0.0	0	0.0
Southeastern Mass University	0	293	0	0	296	0	0	0.0	0	0.0
US International University	0	293	0	0	296	3	0	0.0	3	0.0
Natl Tech University	0	293	0	0	296	0	0	0.0	0	0.0
U Scranton	0	293	12	0	296	11	13	2.6	12	2.9
U Tennessee-Chattanooga	0	293	109	5	228	119	109	0.0	125	4.3
Norwich University	0	293	35	5	228	79	36	0.9	84	6.3
Maine Maritime Academy	0	293	9	1	282	18	9	0.0	18	3.6
U Minnesota-Duluth	0	293	94	1	282	116	94	0.4	117	0.6
U North Dakota	0	293	106	1	282	150	107	0.3	151	0.4
Washington & Lee University	0	293	7	1	282	16	7	4.8	16	4.1
Calvin College	0	293	41	1	282	83	41	0.0	83	0.8
Washington U (STIM)	0	293	0	0	296	0	0	0.0	0	0.0

* HBCU

** HACU

+ Freshmen do not declare major

Note: Engineering institutions included in the Engineering Workforce Commission (EWC) database but excludes the University of Puerto Rico and the Polytechnic University of Puerto Rico. Averages were calculated from available data and rounded to the nearest integer.
Not all institutional averages include three years.

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Table 6
Correlation Between Retention Rates, Financial Aid Awards and Other Relevant Variables

	Minority Retention Rate	Nonminority Retention Rate	Relative Retention Index
Average Financial Aid Funding	**.412+**	.069	**.408+**
Average Federal Pell Grant	**-.222***	**-.273***	-.109
Average State Grant	.153	.129	.100
Average Private Financial Aid Funding	**.254***	.044	**.249***
Average Institutional Financial Aid Funding	**.272***	.031	**.308+**
Public Institutions	**-.329+**	.043	**-.417+**
Private Institutions	**.329+**	.043	**.417+**
Highly Selective Institutions	.215	.119	.172
Very Selective Institutions	**.280***	**.237***	.163
Selective Institutions	**-.218***	-.149	-.123
Less Selective Institutions	**-.296+**	**-.266***	**-.228***

Note: + Correlation is significant at the .01 level (2-tailed test).
* Correlation is significant at the .05 level (2-tailed test).
In this matrix the sample size is the same for each pair of coefficients. That is, only institutions with complete data for all variables considered are included in this matrix. The sample size is 79 institutions. Significant correlations are shown in bold type.

minorities in engineering may be responsive to changes in the types of financial aid awarded from their institutions. If so, it reveals a key policy variable that can be used to improve the minority retention rate and to reduce the attrition of minorities in engineering across all institutions.

Table 6 also shows that nonminority retention rates tend to be lower at institutions with a large number of students receiving Pell grant awards. However, unlike the data for minority students, there is no significant relationship between average privately and institutionally funded financial aid awards and the retention rate of nonminority freshmen. This lack of a significant correlation may indicate that the average nonminority student may have greater access to other resources such as family economic support, or may be more inclined to apply for loans or work while attending school such that their educational costs are financed through a variety of sources.[12] Hence, as private and institutional sources of financial aid shift, these students are able to continue financing their education without interruption.[13] However, a substitution from grants to loans and employment may likely affect the amount of time students take to graduate as well as choice of major.

Multivariate analyses also show that financial aid is a significant predictor in retaining minority students. In the current study, we find that financial aid and institutional control explain ten percent of the observed variance in minority retention rates for the sample of institutions. The estimated coefficient for financial aid is statistically significant at the five percent level. The coefficient on institutional control is not statistically significant. After accounting for institutional selectivity, the explained variance in minority retention rate increases to 15 percent. In addition, the regression coefficient for academic selectivity indicates that the minority retention rate is lower at less selective institutions, holding factors such as financial aid and institutional control constant. This suggests that although financial aid is important, minority students have a greater probability of graduating from academically challenging institutions, and highly competitive educational settings. As is the case for the bivariate analysis, financial aid is not a significant predictor of the nonminority retention rate.

Conclusions

In the often recounted story of the first day in an engineering institution, the dean mounts the podium and ominously introduces the freshman class to the rigors of an engineering education. "Look to your left," the speaker intones prophetically, "look to your right. One of the three of you will not make it to graduation." If only addressing a nonminority audience, sadly, the dean would be correct. For minority students in the same auditorium, however, the unconscionable truth is that two of the three will not make it to graduation.

While minority access to an engineering education has increased substantially over the last 25 years, the production of minority engineers by the nation's colleges and universities remains far below its potential. NACME studies continue to show that retention rates of minority freshmen who enroll in engineering have been intractable since the early 1980s. Based on samples of over 100 institutions, our research indicates that two-thirds of all minority students who enroll in engineering will not earn their engineering degrees, while two-thirds of their nonminority classmates will. This is a widening of the disparity in retention rates since we last analyzed the data in 1995.

Given that the African American, Latino and American Indian men and women who enter engineering are among the best educated minority high school graduates in the country – young people who can choose to major in any discipline at one of our premier institutions – this is an enormous waste of potential at a time when the nation needs it most. On the doorstep of the 21st century, America's burgeoning scientific enterprise has never been more hungry for talent. Engineering employment has surpassed the two million mark, unemployment is below two percent, and year after year, our technology based industries vigorously lobby Congress for an increase in visas to import scientists and engineers. Still, we have not made the investment necessary to produce our own technical workforce from our own underrepresented communities.[14]

African Americans, Latinos, and American Indians comprised only ten percent of the engineering graduating class this year, although they now constitute 30 percent of the college-age population. Confounding the potential for growing participation in the future, minority freshman enrollment has dropped precipitously during the 1990s. Undoubtedly, declining enrollments combined with persistently low retention rates can be expected to lead to decreases in the number of minority engineering graduates for at least the first four years of the new millennium.

This study indicates that investment now is key to increasing the number of minority engineers. Graduation from an institution of higher education results from a multidimensional process involving the interaction

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of the individual, the institution, and the education policies supported by society. In this interaction, the availability of financial aid is one of the key institutional factors affecting students' choice of major and probability of graduation, as indicated both by NACME's engineering-specific data and by the data of other researchers (see, for example, John and Noell,1989; Orfield, 1992).[15] It is indeed fortunate that investment has proven to be such a powerful lever in improving minority attrition. Unlike other institutional factors such as low peer and faculty expectations, unsupportive campus climate, absence of role models, the challenging culture of mathematics and science, and lack of diversity, inadequate financial aid is relatively easy to fix.

At the federal level, policy makers must act aggressively to restore the affordability of a college education. Drastic shifts over the last two decades from grants to loans and the decline in the real purchasing power of the federal Pell grant – while tuition and fees skyrocketed – are inconsistent with the goal of addressing underrepresentation of minority students in higher education (Orfield, 1992). These trends, compounded by changes in financial aid policies at universities, have reduced need-based funding from other sources that have erected barriers to achieving a college education and socioeconomic mobility for the poor who are disproportionately minority. Particularly in rigorous science-based disciplines such as engineering, where the time demands of course work make employment while in school impractical, inadequate funding seriously handicaps the retention prospects of those who enroll. It is therefore essential to restore the purchasing power of the Pell grant to stimulate the poorest segments of the population to choose and persist in an engineering major.

The federal agencies that support the nation's academic research enterprise also have a critical role to play in assuring diversity in the technical workforce. Each year, institutions classified as Research I and Research II receive between $16 million and $40 million in federal support. This high level of commitment to finance excellence in research and education is made possible by all U.S. taxpayers – minority and nonminority – making it incumbent upon receiving institutions to devise systems and policies that are effective in assuring equal education outcomes for all students regardless of race, ethnicity, gender or class. In awarding grants and contracts, it is crucial that the government hold institutions accountable for establishing and meeting human resources goals that serve the full range of American people. This means leveraging awards by linking review criteria to measurable achievements in diversifying both the freshman and graduating classes.

The states too, which are actively competing for new revenue-generating industry in the high-tech sector, bear significant responsibility for developing the highly skilled workers these companies demand. In fact, the overwhelming choice of public institutions by low income minority students magnifies the impact of tuition and financial aid allocations made by state legislatures. To the detriment of retention in engineering at the majority of large state institutions, higher education is in direct competition for funding with both health care and corrections industries, and the latter two are winning. State legislators – enlightened by university and corporate leaders – must begin to weigh the potential returns of investment in education, and specifically engineering education, as an important route to increased corporate tax receipts, accelerated economic development in the minority communities and ultimately, a higher standard of living for every resident of the state.

Finally, our universities need to invest. Since NACME's first studies of retention, we've noted that the institutions posting the greatest achievement in graduating minority engineers often enroll the smallest number of minority freshmen. Conversely, many of the institutions that enroll minorities as a large fraction of their entering freshman engineering class have been dismally unsuccessful in ensuring that these students graduate. This long lived inverse relationship between institutional minority enrollment and retention must not be perpetuated.

America's most highly selective colleges and universities – those that lead the nation in research grants from both corporations and government – are also those that have demonstrated unequivocally that minority scholars in highly competitive environments, despite anti-affirmative action rhetoric, perform extraordinarily well. Responsible for turning out tomorrow's leadership cadre of engineers, these institutions must also be responsible for producing engineers who can communicate effectively across racial, ethnic and gender barriers, and whose creativity is enhanced by access to the world view of others. Such social growth does not occur in homogeneous environments. These institutions must be held accountable at the policy level, by their funders and by their trustees, for investing in a freshman class that much better reflects the composition of the nation's people.

At those universities where a diverse population does exist, at the large public institutions to whom we entrust the lion's share of our best educated minority students, performance must be brought in line with the promise of a college education. NACME believes that an incoming class of minority and nonminority freshmen, admitted to the same institution under the same set of entrance criteria, should anticipate graduating in equal proportions. While the identification of inadequate financial aid as a significant predictor of retention might tempt university administrators to push responsibility to state and federal funders, significant accountability rests with the allocation of existing resources. When year after year, huge numbers of minority freshmen do not return for the second year, institutions need to look at how they are budgeting to fill (or not fill) the seats in the sophomore class, how they are spending their existing financial aid dollars, and how active they are in securing scholarship funding for minority engineering students from all potential sources.

It's time to invest in our nation's future. This year, our country's fastest growing industries will hire more scientists and engineers from abroad than our engineering schools will graduate. Consistently, CEOs of our top producing companies have said

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that developing the human resources to maintain our competitive edge and sustain our economic growth is one of the toughest problems we'll face in the coming years. And all across the policy-making community – in government, the corporate sector and academia – the complex issues of technical workforce development encompass education challenges from kindergarten through graduate school and into the workforce itself. But the most rapid route to expanding the number of minority graduates from our engineering institutions is at hand. By making available high quality scholarships we can significantly increase the retention of the talented young men and women already enrolled – a wise investment in keeping what we've got.

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An earlier version of this study was presented at the annual meeting of the National Association of State Scholarship and Grant Aid Programs.

Endnotes

1. This represents a decline of 72 minority graduates from the 6,446 graduates originally reported by NACME. The number was adjusted after we found that the 1997-98 graduation data released by the Engineering Workforce Commission had overstated the number of minority graduates for Kettering University.

2. Campbell, G., Jr., Denes, R., Friedman, D. L., Miyazaki, L. "Minority Graduation Rates: Comparative Performance of American Engineering Schools." *NACME Research Letter, Vol. 2, No. 2*, NACME, New York, NY, 1991; and Morrison, C., Griffin, K., Marcotullio, P. "Retention of Minority Students in Engineering: Institutional Variability and Success." *NACME Research Letter, Vol. 5, No. 2*, NACME, New York, NY, 1995.

3. Enrollment and graduation data are obtained from the Engineering Workforce Commission which collects annual data on enrollment and graduation of minorities and women from all accredited engineering institutions in the United States under a grant from NACME.

4. Campbell, G., Jr., Denes, R., Friedman, D. L., Miyazaki, L. "Minority Graduation Rates: Comparative Performance of American Engineering Schools." *NACME Research Letter, Vol. 2, No. 2*, NACME, New York, NY, 1991; and Morrison, C., Griffin, K., Marcotullio, P. "Retention of Minority Students in Engineering: Institutional Variability and Success." *NACME Research Letter, Vol. 5, No. 2*, NACME, New York, NY, 1995.

5. Data on each institution's academic selectivity were obtained from *Peterson's Guide to Four-Year Colleges: 1998, 28th Edition*. Peterson's, Princeton, NJ, 1997. An institution's academic selectivity classification falls in one of five categories:

   - Highly selective institutions select students from the top 10 percent of their high school graduating class.
   - Very selective institutions select students from the top 25 percent of their high school graduating class.
   - Selective institutions select students from the top 50th percentile or higher of their high school graduating class.
   - Less selective institutions select students from the lower 50th percentile and higher of their high school graduating class;
   - Non selective institutions have an open admission policy.

6. In the sample of 117 institutions that met the criteria for inclusion in the study, there were no private less selective or private non selective institutions. Only the University of Virginia, a highly selective public institution met the criteria for inclusion in the sample, which is not included in Figure 4.

7. The data on financial aid awards were obtained from the Integrated Postsecondary Education Data System, 1995 (IPEDS). The data are collected yearly from all U.S. colleges and universities by the National Center for Education Statistics. At the time of this analysis, the 1991 through 1995 IPEDS data were available. Note that the 1991 to 1995 academic year for which data were extracted covered the time period that the engineering freshman cohorts included in this analysis were enrolled. An average institutional financial aid award per student per year was calculated. Then an average value for 1991 to 1995 was calculated and adjusted by the consumer price index (CPI-U, 1982-84 = 100). The consumer price index data were obtained from the U.S. Bureau of Labor Statistics web site on February 19, 1999 (www.bls.gov).

8. U.S. General Accounting Office, *Restructuring Student Aid Could Reduce Low-Income Student Dropout Rate*, Washington, DC, March 1995.

9. See "Pell Grant Program Participation FFY 1974 to FFY 1999." *Postsecondary Education OPPORTUNITY, No. 67*, January 1998.

10. The Education Resources Institute, Inc., *Do Grants Matter? Student Grant Aid & College Affordability*, Washington, DC, November, 1998.

11. Ibid.

12. Using individual-level data from the 1980 and 1982 High School and Beyond database, St. John and Noell (1989) find that financial aid had a significant positive impact on enrollment decisions of African Americans, Latinos, and whites. However, after controlling for family background they find that financial aid had a stronger impact on access for minority students than for whites. For more detailed information on the study the reader is referred to: St. John, E. P., Noell, J. "The Effects of Student Financial Aid on Access to Higher Education: An Analysis of Progress with Special Consideration of Minority Enrollment." *Research in Higher Education*, Vol. 30, No. 6, 1989.

13. Note that the correlation coefficients do not reveal any information about time to graduation.

14. Campbell, G., Jr., "Engineering and Affirmative Action: Crisis in the Making", *NACME Research Letter*, Special Edition, NACME, New York, NY 1997.

15. Orfield examines the relationship between money and access to college for minority and poor students. In the analysis Orfield finds that finances limit the choices of minority students. Particularly, African American students are more dependent on financial aid in order to persist in college than their white counterparts. For more details on this study the reader is referred to: Orfield, G. "Money, Equity, and College Access." *Harvard Educational Review*, Vol. 62, No. 3, Fall 1992.

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Appendix: Excluded Institutions

Institutions With Increase in Minority Freshman-to-Sophomore Enrollment Exceeding 15 Percent

Institution	Percentage Change Freshman-Sophomore Minority Enrollment 1991-92, 1992-93	Percentage Change Freshman-Sophomore Minority Enrollment 1992-93, 1993-94	Percentage Change Sophomore-Junior Minority Enrollment 1992-93, 1993-94	Percentage Change Freshman-Sophomore Nonminority Enrollment 1991-92, 1992-93	Percentage Change Freshman-Sophomore Nonminority Enrollments 1992-93, 1993-94
Arizona State University	0.23	-0.09	0.63	0.01	-0.04
Columbia University	0.07	0.17	-0.07	-0.03	-0.08
Cooper Union	0.00	0.32	0.23	-0.02	0.03
Cornell University	-0.01	0.31	-0.26	-0.05	0.00
Drexel University	0.19	-0.09	-0.30	0.21	-0.02
FAMU/FSU College of Engrg	0.28	-0.38	-0.33	-0.30	-0.30
Florida Intl University	2.22	2.05	3.48	1.44	2.29
NY Institute of Tech	0.18	0.36	1.07	-0.13	0.00
Purdue Univ-Calumet	-0.75	0.30	1.67	-0.76	0.19
Rochester Inst of Tech	0.26	-0.50	-0.55	-0.15	-0.27
SUNY-Stony Brook Campus	0.30	-0.15	0.31	-0.08	-0.24
U Connecticut	0.28	0.36	-0.59	0.36	0.43
U Maryland-Baltimore	0.62	-0.45	-0.55	0.10	-0.49
U Memphis	0.76	0.29	-0.37	0.07	-0.53
U Minnesota	0.33	-0.37	0.50	0.12	-0.09
U New Mexico	0.26	-0.01	-0.60	0.71	0.30
Worcester Poly Institute	-0.20	0.17	0.50	0.07	-0.04

Institutions With Increases in Minority Sophomore-to-Junior Enrollment Exceeding 15 Percent

Boston University	-0.42	-0.20	0.22	-0.12	-0.14
Cal State U-Chico	-0.59	-0.69	0.18	-0.32	-0.44
Cal State U-Fresno	-0.35	-0.35	0.66	-0.34	-0.41
Cal State U-Long Beach	-0.48	-0.60	0.77	-0.30	-0.35
Cal State U-Northridge	-0.13	-0.39	0.44	-0.51	-0.52
Cal State U-Sacramento	-0.53	-0.69	0.98	-0.33	-0.57
Carnegie Mellon Univ	-0.75	-0.49	0.56	0.14	-0.06
CCNY (City College, CUNY)	-0.57	-0.40	0.34	-0.58	-0.20
Cleveland State Univ	-0.82	-0.85	3.67	-0.61	-0.38
Florida Atlantic Univ	-0.56	-0.39	2.09	-0.33	-0.46
Georgia Inst of Tech	-0.18	0.07	0.25	-0.06	-0.20
Johns Hopkins University	-0.20	-0.37	0.25	-0.17	-0.15
McNeese State University	-0.86	-0.13	1.00	-0.53	-0.48
Mercer University	-0.69	-0.81	2.20	-0.52	-0.44
New Jersey Inst Tech	-0.46	-0.58	0.47	-0.44	-0.31
NM Inst of Mining & Tech	-0.53	-0.45	1.07	-0.17	-0.57
Northeastern University	-0.30	-0.26	0.57	-0.22	-0.31
San Diego State Univ	-0.52	-0.62	0.59	-0.46	-0.42
San Francisco State University	-0.47	-0.33	0.40	-0.48	-0.51
San Jose State University	-0.33	-0.40	0.89	-0.45	-0.54
Stevens Inst of Tech	-0.14	-0.13	0.50	-0.11	-0.08
Texas A&M University	-0.47	-0.49	0.24	-0.20	-0.21
Texas Tech University	-0.72	-0.45	0.31	-0.36	-0.35
U Alabama-Huntsville	-0.38	-0.45	0.38	-0.35	-0.40
U Cal-Berkeley	-0.58	-0.32	1.04	-0.23	-0.31
U Cal-Irvine	-0.33	-0.18	0.33	-0.27	-0.26
U Cal-Los Angeles	-0.38	-0.22	0.28	-0.13	-0.10
U Cal-Santa Barbara	-0.20	-0.23	0.20	-0.31	-0.17
U Iowa	-0.67	-0.47	0.60	-0.34	-0.23
U Kansas	-0.68	-0.65	0.56	-0.35	-0.40
U Maryland-College Park	-0.34	-0.25	0.24	-0.31	-0.30
U Miami	-0.56	-0.27	0.32	-0.30	-0.26
U Missouri-Columbia & KC	-0.55	-0.58	0.20	-0.23	-0.27
U Missouri-Rolla	-0.21	-0.37	0.16	-0.31	-0.35
U South Florida	-0.12	-0.15	0.48	-0.32	-0.24
U Texas-Arlington	-0.73	-0.35	0.22	-0.46	-0.40
U Toledo	-0.82	-0.69	1.43	-0.63	-0.62
U Wisconsin-Milwaukee	-0.18	0.13	-0.36	0.30	-0.03
U Wisconsin-Platteville	-0.90	-0.62	1.00	-0.50	-0.46
Villanova University	-0.60	-0.71	0.75	-0.39	-0.39
Washington State Univ	-0.28	-0.52	-0.44	0.94	0.17

Appendix: Excluded Institutions

Institutions Where Freshmen Do Not Declare Major

California Institute of Technology
Harvard University
Massachusetts Institute of Technology

Institutions Where Freshman Enrollment Data Were Not Reported in at Least One Year

Air Force Inst of Tech
Capitol College
Cedarville College
Cogswell College North
College of St Thomas
Colorado Technical Univ
Fairfield University
Geneva College
Humboldt State University
Northrop University
Pratt Institute
Southeastern Mass Univ
Trenton State College
Trinity College
U NC-Chapel Hill
U of Southern Maine
U Redlands
U San Diego
U Texas-Pan American
U Texas-Permian Basin
U West Va-Grad Studies
U Wisconsin-Parkside
Univ of North Florida
US International Univ
US Military Academy
US Naval Academy
US Naval Postgraduate Sch
Washington U (STIM)
Wentworth Inst of Tech
Winona State University
U Florida
SUNY-Binghamton Campus

Note: Three additional institutions were excluded but are not listed in the appendix. The University of Wisconsin-Milwaukee and Washington State University were excluded because they had an increase in nonminority freshman-to-sophomore enrollments exceeding 15 percent. Hampton University did not enroll nonminority freshmen during the period of the study although 1 nonminority student graduated in 1996-97, and 2 graduated in 1997-98. The minority retention rate at Hampton University is 9 percent.

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Appendix: Excluded Institutions

Institutions With Minority Freshman Class of Less Than Ten Students in at Least One Year

Institution	Total Minority Freshmen Enrolled 1991-92	Total Nonminority Freshmen Enrolled 1991-92	Total Minority Freshmen Enrolled 1992-93	Total Nonminority Freshmen Enrolled 1992-93	Total Minority Freshmen Enrolled 1993-94	Total Nonminority Freshmen Enrolled 1993-94
Alfred U/SUNY Ceramics	4	111	10	134	4	118
Arkansas State University	16	103	0	114	0	149
Arkansas Tech University	2	72	4	78	5	83
Baylor University	5	76	8	72	13	65
Bradley University	3	62	5	83	6	94
Brigham Young University	5	382	15	575	24	543
Bucknell University	9	171	6	174	9	140
Calvin College	2	93	0	67	0	88
Case Western Reserve U	3	14	1	21	3	12
Catholic Univ of America	8	46	5	56	5	56
Christian Brothers University	6	69	7	67	10	74
Citadel	11	113	8	111	4	113
College of Staten Island	13	58	14	45	9	58
Dartmouth College	9	61	12	79	11	82
Dordt College	1	19	0	14	0	29
Embry Riddle U-Prescott	9	142	7	144	8	198
Fairleigh Dickinson University	2	17	9	12	4	10
Ferris State University	0	6	0	6	0	8
Gannon University	2	52	0	39	1	30
Gonzaga University	1	98	8	87	10	73
Grand Valley State University	15	41	7	73	11	74
Grove City College	0	164	0	129	0	120
Harvey Mudd College	7	98	8	83	8	84
Hofstra University	4	48	5	57	19	59
Idaho State University	3	112	3	93	7	90
John Brown University	0	28	0	39	0	41
Lafayette College	14	116	5	124	4	120
Le Tourneau University	3	75	3	80	3	83
Loyola College	1	13	1	17	4	18
Maine Maritime Academy	2	23	0	19	0	11
Mankato State University	2	160	2	141	0	136
Marietta College	0	16	0	23	0	18
Merrimack College	0	35	1	32	3	37
Messiah College	2	31	0	34	3	46
Miami University	2	114	6	138	14	130
Monmouth College	4	15	1	11	1	7
Montana State University	8	549	14	429	17	399
Montana Tech of U Montana	5	249	10	282	3	284
ND State University	11	275	2	298	3	342
New England College	0	10	0	10	1	6
Northeastern State University	1	5	2	4	1	3
Norwich University	4	87	8	90	4	60
Ohio Northern University	5	141	4	186	7	180
Oklahoma Christian University	0	54	3	49	3	46
Oral Roberts University	0	18	0	11	0	13
Oregon State University	0	558	0	477	0	571
Parks College-St Louis U	5	53	10	79	7	47
Portland State University	3	105	6	74	12	105
Purdue Univ-Ft Wayne	1	92	8	88	1	102
Purdue Univ-Indianapolis	5	37	3	38	0	37
Rose-Hulman Inst of Tech	8	283	8	308	8	308
Saginaw Valley State U	9	40	5	67	7	59
SD School of Mines & Tech	7	318	13	311	13	391
SD State University	2	366	4	369	2	340
Seattle Pacific University	0	25	0	31	0	29
Seattle University	4	92	6	46	4	55
So Illinois-Edwardsville	5	5	1	9	5	22
Southern Methodist University	0	140	49	115	37	88
St Ambrose University	2	5	1	5	1	0
St Cloud State University	4	83	3	60	1	65
St Martins College	0	9	0	12	0	8
St Marys University	0	37	29	13	15	17
SUNY College at New Paltz	3	20	4	10	8	14
SUNY College of Env Science	5	24	6	28	4	38
SUNY Maritime College	22	105	7	61	16	1
Swarthmore College	1	48	4	37	8	54
Temple University	4	19	4	21	11	39
Texas A&M U-Galveston	2	31	8	37	3	43
Tri-State University	3	116	3	132	5	157
Trinity University	9	61	1	51	1	48
Tufts University	5	170	3	190	2	176
U Alaska-Anchorage	4	40	4	49	4	37
U Bridgeport	8	62	2	12	4	33
U Cal-Riverside	8	61	9	56	10	33
U Colorado-Colorado Spgs	3	47	4	43	11	69
U Colorado-Denver	2	34	7	25	3	41
U Dayton	9	283	17	335	14	278
U Denver	3	33	3	32	6	54
U Detroit	9	62	9	62	42	74
U Evansville	1	77	2	74	2	81
U Georgia	2	21	4	19	6	26
U Hartford	8	78	9	92	15	71
U Hawaii	1	157	0	189	0	162
U Maine-Orono	1	310	3	284	3	242
U Massachusetts-Dartmouth	2	165	2	138	9	146
U Minnesota-Duluth	0	109	1	120	1	120
U Nebraska-Lincoln	9	334	6	422	6	391
U Nevada-Reno	7	157	9	165	13	146
U Nevada-Sch of Mines	1	26	1	33	2	40
U New Hampshire	0	205	0	205	0	179
U North Dakota	0	127	0	161	2	162
U Pacific	6	55	10	65	17	65
U Portland	2	57	4	64	1	73
U Tennessee-Chattanooga	16	62	0	148	0	148
U Texas-Dallas	7	15	7	22	10	63
U Tulsa	9	146	13	150	12	129
U Vermont	3	230	3	204	8	176
U Washington	0	50	51	27	11	24
Union College	8	85	3	63	4	88
US Air Force Academy	24	123	2	3	0	5
US Merchant Marine Acad	6	164	4	137	7	138
Utah State University	5	310	7	277	5	125
Valparaiso University	6	84	3	92	4	83
Virginia Military Institute	13	118	7	141	16	99
Walla Walla College	3	58	7	61	3	34
Washington University	17	192	9	171	9	238
Wayne State University	79	210	85	191	0	242
Webb Inst of Naval Arch	2	21	1	22	0	25
West Virginia Inst Tech	7	229	3	233	3	194
West Virginia University	29	387	17	327	8	334
Western New England Coll	0	97	8	81	6	74
Widener University	0	104	0	104	0	104
Wilkes University	0	39	3	67	3	67
Yale University	0	1	4	26	3	25
Youngstown State University	0	276	1	283	13	184

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